Littoral Acoustic Demonstration Center

USM Grant Portion Final Report

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Abstract

The Littoral Acoustic Demonstration Center was formed by scientists from the University of Southern Mississippi (USM), the University of New Orleans (UNO), and the Stennis Detachment of the Naval Research Laboratory (NRL), and maintained that structure for most of the duration of this grant. It has now been expanded to include scientists from the University of Louisiana-Lafayette. The funding that permitted the formation of the consortium was provided by the Office of Naval Research with the aim of studying ambient noise and marine mammals, particularly as each occurs in the Gulf of Mexico. Two successful deployments of hydrophones were made in the Gulf of Mexico under the auspices of consortium members USM and NRL Stennis during the summers of 2001 and 2002. NRL Stennis also assisted in deployments in the Mediterranean Sea in the summers of 2002 and 2003. Minor assistance in one of these deployments (2002) was provided by USM. All three institutions provided assistance with data analysis with UNO providing leadership in several areas including oversight of virtually all of the ambient noise studies. The project also provided financial support for numerous graduate students and resulted in several talks by them as well as theses and dissertations.

Goals for marine mammals included their detection, identification, and tracking using bottom-moored hydrophones, although only sperm whale vocalizations have been studied thus far. A new detection algorithm for sperm whale clicks has been developed and used and compared to traditional algorithms. Methods have been developed for the identification of individual sperm whales based on their codas and echo-location clicks. Analysis of sperm whale activity levels has been performed and the effects of ship noise investigated.

Introduction

The Littoral Acoustic Demonstration Center (LADC) was founded in June 2001 as a consortium of scientists from universities and the Navy. Initially it consisted of the University of Southern Mississippi (USM), the University of New Orleans (UNO), and the Naval Research Laboratory at Stennis Space Center (NRL-SSC). The University of Louisiana at Lafayette (UL Lafayette) has since become a part of the group. Its formative funding was provided by the Office of Naval Research (ONR). LADC was formed to conduct ambient noise and marine mammal acoustic measurements and analyses in shallow water. The original concentration of LADC research has since been broadened to include airgun calibration measurements.

LADC ONR grant support funding to all institutions was as follows:

Littoral Acoustic Demonstration Center, Phase I, George E. Ioup, Juliette W. Ioup, Grayson H. Rayborn (USM) Robert L. Field (NRL Stennis), ONR, $1,500,000, 1 June 01 - 30 Sept 04 (Operating Costs: UNO $292,500, USM $292,500, NRL $278,070; Equipment: USM $561,930, NRL $75,000).

Littoral Acoustic Demonstration Center, Phase II, George E. Ioup, Juliette W. Ioup, Grayson H. Rayborn (USM), and Robert L. Field and Joal Newcomb (NRL Stennis), Office of Naval Research, $961,000, 1 Jul 2002 - 30 Sep 2004 (Operating Costs: UNO $260,140, USM $263,350, NRL $324,250; Equipment: NRL $113,260).

USM assumed responsibility for the purchase of most of the major equipment and, with the help of NRL Stennis, oversaw the letting of the contract for the hydrophone arrays and conformity with specifications in their construction and delivery.

LADC Experiments

The University of Southern Mississippi negotiated and signed a Cooperative Research and Development Agreement (CRADA) with the Naval Oceanographic Office. This agreement permitted USM, and hence the LADC consortium, access to the technology for acquisition of sound from bottom moored hydrophones developed by the Naval Oceanographic Office (NAVOCEANO). In return NAVOCEANO was permitted access to data acquired in the course of LADC measurements. NAVOCEANO has provided technical advice and guidance throughout the existence of LADC. All LADC underwater acoustic measurements have all been performed using Environmental Acoustic Recording System (EARS) buoys developed at Stennis Space Center by the Naval Oceanographic Office.

Major experimental exercises have included two sets of measurements with three separated bottom-moored hydrophones (EARS buoys) in the Gulf of Mexico during the summers of 2001 and 2002, two sets of Mediterranean Sea measurements, the first in the Corsica-Ligurian Basin (summer 2002) and the second in the Genoa Canyon (summer

2003), and airgun calibration measurements in the Gulf of Mexico in the summer of 2003. The first two experiments were done entirely by LADC. A consortium that included LADC did the second two sets in the Mediterranean Sea, which have the names SIRENA02 and SIRENA03. LADC has also performed a calibration of a marine seismic source. Although this project follows the theme of the ONR grant in that it provided data for use by regulatory agencies in safeguarding marine mammals, it was not funded by ONR. It was, instead, funded by the oil industry through the Industry Research Funding Coalition through the International Association of Geophysical Contractors. The success of the airgun experiments depended heavily on the equipment and expertise developed over the course of earlier LADC research. Details of all these experiments are in a folder attached to the Final Report for this project submitted by the University of New Orleans called LADC Experiments. The lead in writing these experimental descriptions was Dr. Joal Newcomb, the current LADC PI at the Naval Research Laboratory-Stennis Space Center.

Marine mammal goals have included the detection, identification, and tracking of marine mammals using bottom-moored hydrophones and have thus far concentrated on sperm whales. In addition to using existing detection algorithms, a new detection algorithm for sperm whale clicks has been developed. Methods have been developed for the identification of individual sperm whales based on their codas and echo-location clicks. Analysis of sperm whale activity levels has been performed. This has included investigation of the effects of ship noise.

For the airgun calibration performed in the summer of 2003, a seismic exploration vessel, the *Kondor*, was used to provide airgun shots along predetermined tracks at given offsets from an EARS buoy, including one track almost directly overhead. Sensitive and desensitized hydrophones were employed to make the measurements without clipping. These results have been analyzed and reported, and analysis is continuing.

Publications describing the above results are contained in the attachments for the Final Report of the University of New Orleans. A summary list of publications involving authors associated with USM is given herein.

Ambient noise analyses have included comparing the noise measured during the nearby passage of major storms (tropical storms Barry and Isidore and hurricane Lili) to predicted noise levels for various wind speeds. Analyses have also been directed toward the development of forward prediction algorithms for ambient noise based on measurements.

Graduate Students Supported

The following University of Southern Mississippi students had their research supported in whole or in part by this grant.

Christopher Walker	8/20/01—5/31/03	undergraduate & graduate
Benjamin Brack	5/20/02--12/19/02	undergraduate

David Prehn	6/7/02--8/2/02	high school student
Kimberley Williams	6/7/02—8/16/02	visiting undergrad
Marie Trone	8/15/01—4/30/02	graduate student
Robin Paulos	8/15/01—8/31/03	graduate student
Joana Ramos	4/1/02—8/31/03	graduate student
Sergey Vinogradov	1/1/03—9/30/03	graduate student
Jill Maroo	6/01/04—8/31/04	graduate student
Rachel Thames	6/01/04—8/31/04	graduate student

Undergraduate students were supported with wages and graduate students were ordinarily supported with graduate research assistantships. Students were supported in the academic departments of Marine Science, Physics & Astronomy, and Psychology. Two dissertations resulted from the research of these students supported in whole or part by this grant and a number of theses and dissertations are in still in progress.

"The use of tomographic data in the numeric modeling of mesoscale eddy propagation in the Northern Gulf of Mexico". Doctoral dissertation, Sergey Vinogradov, Univ. of Southern Miss., 2005

"Investigation into the potential effects of anthropogenic noise on sperm whale sound production (*Physeter Macrocephalus*) in the Gulf of Mexico", Doctoral dissertation, Rachel Thames, University of Southern Mississippi, May, 2005.

LADC/USM Talks and Publications

The following talks and publications resulted in research supported in whole or part by this grant. University of Southern Mississippi authors are indicated by bold faced font.

Talks

Ioup, G.E., Ioup, J.W., Sidorovskaia, N.A., Walker, R. T., Kuczaj, S.A., **Walker, C.D., Rayborn, G.H., Brack, B.,** Wright, A., Newcomb, J. & Fisher, R. (in press). Analysis of Bottom-Moored Hydrophone Measurements of Gulf of Mexico Sperm Whale Phonations, Proceedings of the Information Transfer Meeting of the Minerals Management Service.

Kuczaj, S.A. II, Paulos, R., Ramos, J., Thames, R., Rayborn, G., Walker, C., Ioup, G., Ioup, J., Snyder, M., Field, R., Newcomb, J., Fisher, R., **Caruthers, J.,** Goodman, R., & Sidorovskaia, N. . Anthropogenic noise and sperm whale sound production. Meeting of the European Cetacean Society.

Vinogradov, S., J. W. Caruthers, and N. Sidorovskaia. 2003. Physical oceanographic conditions during LADC-01 experiment". Poster and proceedings of OI Americas 2003 Conference, New Orleans, LA, 4 – 6 June 2003. Also in *Proceedings of 145th ASA Conference*, Nashville, TN, 2003

Wright, A. J., Goold, J.C., **Kuczaj, S.A. II, Thames, R.,** Newcomb, J., Mellinger, D. K. & Snyder, M. (in press). Bathymetry, meteorology and diurnal patterns in sperm whale behaviour. Meeting of the European Cetacean Society.

Vinogradov, S., J. W. Caruthers, and N. Sidorovskaia. "The use of tomographic data in numeric simulation of eddy propagation into the Northeastern Gulf of Mexico by assimilation into the numeric model". Poster presentation in ASLO/TOS Ocean Research Conference, Honolulu, HI, February 15 – 20 2004.

Invited Talks

"The use of ocean tomographic data in the numerical simulation of mesoscale eddy propagation in the Northern Gulf of Mexico"., **J. Caruthers**, Physics Seminar Sigma Pi Sigma, Dept of Physics; University of Louisiana-Lafayette, Lafayette, LA. March 24, 2004.

"The use of ocean tomographic data in the numerical simulation of mesoscale eddy propagation in the Northern Gulf of Mexico" **J. Caruthers** ChevronTexaco Corporation, Houston, TX. 4 May, 2004

"Mesoscale Circulation and Variability of the Coastal Ocean: Numerical Modeling, Data Analysis and Ocean Acoustics", **J. Caruthers**. Graduate College of Marine Science; University of Delaware, Newark, DE. 14 October, 2004.

"Acoustic and oceanographic modeling in support of tomography in the Gulf of Mexico", **J. Caruthers**. Oceanography and Climate Sack Lunch Seminars, Dept of Earth, Atmospheric, and Planetary Sciences; Massachusetts Institute of Technology, Cambridge, MA. April 6, 2005.

Papers

Newcomb, J., Fisher, R., Field, R., Ioup, G., Ioup, J., **Rayborn, G., Kuczaj, S., Caruthers, J.,** Goodman, R., & Sidorovskaia, N. (2004). Using Acoustic Buoys to Assess Ambient Noise and Sperm Whale Vocalizations. Published in the *Proceedings of the Information Transfer Meeting of the Minerals Management Service*, pp. 269-276.

Newcomb, J., Fisher, R., Field, R., **Rayborn, G., Kuczaj, S.,** Ioup, G., Ioup, J. & Turgot, A. (2002). Measurements of Ambient Noise and Sperm Whale Vocalizations in the Northern Gulf of Mexico Using Near Bottom Hydrophones. *Proceedings of MTS/IEEE OCEANS2002*, pp. 1365-1371.

Newcomb, J., Fisher, R., Turgot, A., Field, R., Ioup, G., Ioup, J., **Rayborn, G., Kuczaj, S., Caruthers, J.,** Goodman, R., & Sidorovskaia, N. (2002). Modeling and Measuring the Acoustic Environment of the Gulf of Mexico. *Proceedings of the Information Transfer Meeting of the Minerals Management Service*, pp509-521.

Vinogradov, S., J. W. Caruthers, and N. Sidorovskaia. 2003. Physical oceanographic conditions during LADC-01 experiment". Poster and proceedings of OI Americas 2003 Conference, New Orleans, LA, 4 – 6 June 2003. Also in *Proceedings of 145th ASA Conference*, Nashville, TN, 2003

Caruthers, J. W., S. Vinogradov, N. Vinogradova, N. A. Sidorovskaia, G. E. Ioup, J. W. Ioup, and I. Udovydchenkov, 2003. Gulf of Mexico oceanography and acoustic-pulse propagation across the DeSoto Canyon. *J. Acoust. Soc. Am.*, Vol. 114, No. 4, Pt. 2, p 2376

Kuczaj, S.A. II, Paulos, R., Ramos, J., Thames, R., Rayborn, G., Walker, C., Ioup, G., Ioup, J., Snyder, M., Field, R., Newcomb, J., Fisher, R., **Caruthers, J.,** Goodman, R., & Sidorovskaia, N. (in press). Anthropogenic noise and sperm whale sound production. *Proceedings of the European Cetacean Society.*

Wright, A. J., Goold, J.C., **Kuczaj, S.A. II, Thames, R.,** Newcomb, J., Mellinger, D. K. & Snyder, M. (in press). Bathymetry, meteorology and diurnal patterns in sperm whale behaviour. *Proceedings of the European Cetacean Society.*

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scientists at NRL-SSC; to Professor Juliette Ioup and Professor George Ioup of the University of New Orleans; and to Natalia Sidorovskaia. Bill Lang of MMS and Bob Gisiner of ONR provided wise counsel and crucial introductions. All of these persons deserve the sincere and hearty thanks here offered.

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